Claims

Having set forth a preferred embodiment of the present invention, what is claimed is:

1. A system for automatically inspecting a workpiece for the perimeter and holes formed therein, said system comprising of:

an inspection table having a transparent glass surface upon which the workpiece is to be laid;

an etched glass calibration scale located at the edge of the glass surface of the table for sensor scale calibration;

a carriage mounted on rails on the table, which is movable in a first direction; containing a light source, and an optical sensor module, which is movable in a second direction perpendicular to the first;

a CCD camera with an imaging sensor consisting of plurality of CCD photo sensing elements, and an optical configuration situated within said optical sensor module;

a computer workstation interfacing with motion control positioning subsystems, providing computer controlled two-axis motion control positioning of the carriage in one direction and the optical sensor module in a second direction perpendicular to the first;

a video edge processor board situated within said computer providing the means for synchronizing the CCD camera and the processing of edge address data computer processing;

Wherein the optics within the optical sensor module are configured to align the viewing angle of each photo-sensing element of the multiple element sensors so that they are perpendicular to and focused at or above the surface of the transparent table top.

2. The inspection system recited in claim 1, wherein then carriage is mounted on rails and movable in the first direction, by a motor driven mechanical drive with optical encoder position feedback, controlled by a motion controller in a closed loop

servo configuration.

3. The carriage recited in claim 2, wherein the carriage is comprised of an upper shelf containing a fluorescent lamp and a lower shelf with an optical sensor module mounted onto rails and movable in the second direction by motor mechanical driven drive with an optical encoder feedback, controlled by the motion controller in a closed loop servo configuration.

4. The carriage recited in claim 3, wherein the fluorescent lamp is positioned above the transparent glass table surface in an opposing alignment with the optical sensor module below the surface, illuminating the optical port of the optical sensor module around the perimeters and through holes of the workpiece over its travel in the second direction.

5. The inspection systems recited in claim 1, wherein the imaging sensor contained with the CCD camera is a time delay integration charged coupled device; comprised of a plurality of rows and columns of photo sensing elements, with the rows aligned perpendicular to the first direction; wherein the motion of the carriage in the first direction is synchronized with the scanning of the imaging sensor so that as the image passes each row of sensor elements, the signal charge generated in the sensor is passed from one row to the next row, with the signals being summed over the plurality of rows before being transferred to a readout shift register; and providing an indication of the location of the edges of the perimeter and holes in the workpiece, relative to the location of the optical sensor and its photo sensing elements as it scans the on the table surface.

6. The inspection system recited in claim 1, wherein the optical sensor module is configured in an optical arrangement comprised of the imaging sensor, an enlarging lens; a mirror to fold the optical path to achieve a compact module, and a plano-

convex lens. Wherein the front nodal point of the enlarging lens is positioned at the effective focal point of the plano-convex lens to aligned the viewing angle of each photo sensing element of the multiple element sensor is perpendicular to the surface of the table and the workpiece.

7. The inspection system recited in claim 1, wherein the CCD camera is comprised of the circuitry for timing and synchronization, analog to digital video conversion, and interfacing with the CCD sensor and edge data processor board.

8. The inspection system recited in claim 1, wherein the computer workstation is comprised of a computer for data interfacing, processing and storage; plug-in circuit board slots; and software for data manipulation, measurement and comparison computations; and computer peripherals for data display and printing.

9. The inspection system recited in claim 1, wherein the edge data processor board plugs into the computer and is comprised of circuitry for interfacing with the clock, timing and digital video signals from the CCD camera, bi-phase signal from the X-axis linear encoder; and run length encoding of edge addresses and end of line into a first-in-first-out memory for buffering the data onto the computer data bus.

10. A system for automatically inspecting a workpiece for the perimeter and holes formed therein, said system comprising of:

an inspection table having a transparent glass surface upon which the workpiece is to be laid;

an etched glass calibration scale located at the edge of the glass surface of the table for sensor scale calibration;

a carriage mounted on rails on the table, which is movable in a first direction; containing a light source, and an optical sensor module, which is movable in a second direction

perpendicular to the first;

a CCD camera with an imaging sensor consisting of a plurality of CCD photo sensing elements in rows and columns, an enlarging lens, and a plano-convex lens situated within said optical sensor module;

a computer workstation interfacing with motion control positioning subsystems, providing computer controlled two-axis motion control positioning of the carriage in one direction and the optical sensor module in a second direction perpendicular to the first; and a video edge processor board

a video edge processor board situated within said computer providing the means for synchronizing the CCD camera and the processing of edge address data computer processing;

Wherein the front nodal point of the enlarging lens is positioned at the effective focal point of the plano-convex lens and the positioning of CCD sensor is to align the viewing angle of each photo-sensing element of the multiple element sensor is perpendicular to the surface of the table and the workpiece.

11. The inspection system recited in claim 1, wherein the carriage is mounted on rails and movable in the first direction, by a motor driven mechanical drive with optical encoder position feedback, controlled by a motion controller in a closed loop servo configuration.

12. The carriage recited in claim 11, wherein the carriage is comprised of an upper shelf containing a fluorescent lamp; and a lower shelf with an optical sensor module mounted onto rails and movable in the second direction by motor mechanical driven drive with an optical encoder feedback, controlled by the motion controller in a closed loop servo configuration.

13. The carriage recited in claim 12, wherein the fluorescent lamp is positioned above the transparent glass table surface in an opposing alignment with the optical sensor module below the

surface, illuminating the optical port of the optical sensor module around the perimeters and through holes of the workpiece over its travel in the second direction.

14. The inspection systems recited in claim 10, wherein the imaging sensor contained with the CCD camera is a time delay integration charged coupled device; comprised of a plurality of rows and columns of photo sensing elements, with the rows aligned perpendicular to the first direction; wherein the motion of the carriage in the first direction is synchronized with the scanning of the imaging sensor so that as the image passes each row of sensor elements, the signal charge generated in the sensor is passed from one row to the next row, with the signals being summed over the plurality of rows before being transferred to a readout shift register; and providing an indication of the location of the edges of the perimeter and holes in the workpiece, relative to the location of the optical sensor and its photo sensing elements as it scans the on the table surface.

15. The inspection system recited in claim 1, wherein the CCD camera is comprised of the circuitry for timing and synchronization, analog to digital video conversion, and interfacing with the CCD sensor and edge data processor board.

16. The inspection system recited in claim 10, wherein the computer workstation is comprised of a computer for data interfacing, processing and storage; plug-in circuit board slots; and software for data manipulation, measurement and comparison computations; and computer peripherals for data display and printing.

Wherein the edge data processor board plugs into the computer and is comprised of circuitry for interfacing with the timing and digital video signals from the CCD camera, bi-phase signal from the X-axis linear encoder; and run length encoding of edge addresses and end of line into a first-in-first-out memory for

buffering the data onto the computer data bus.

17. A system for automatically inspecting a workpiece for the perimeter and holes formed therein, said system comprising of:

an inspection table having a transparent glass surface upon which the workpiece is to be laid;

an etched glass calibration scale located at the edge of the glass surface of the table for sensor scale calibration;

a carriage mounted on rails on the table, which is movable in a first direction; containing a light source, and an optical sensor module, which is movable in a second direction perpendicular to the first;

a CCD camera with an imaging sensor consisting of plurality of CCD photo sensing elements in rows and columns, and an enlarging lens, and a plano-convex lens situated within said optical sensor module;

a computer workstation interfacing with motion control positioning subsystems, providing computer controlled two axis motion control positioning of the carriage in one direction and the optical sensor module in a second direction perpendicular to the first; and

a video edge processor board situated within said computer providing the means for synchronizing the CCD camera and the processing of edge address data computer processing;

wherein the front nodal point of the enlarging lens is positioned at the effective focal point of the plano-convex lens and CCD sensor is positioned so that the viewing angle of each photo-sensing element of the multiple element sensor is perpendicular to the surface of the table and the workpiece;

wherein the carriage is mounted on rails and movable in the first direction with a mechanization driven in a closed loop servo configuration by a servo motor module comprised of a micro-processor, rotary shaft encoder, power amplifier and motor contained within a single modular enclosure;

wherein the carriage is comprised of an upper shelf

containing a fluorescent lamp illuminating the top surface of the table and the workpiece in opposing alignment with the optical sensor module mounted on a lower shelf;

wherein the optical sensor module mounted onto rails and movable in the second direction by a mechanization driven in a closed loop servo configuration by a servo motor module comprised of a micro-processor, rotary shaft encoder, power amplifier and motor contained within a single modular enclosure;

wherein the imaging sensor contained with the CCD camera is a time delay integration charged coupled device; comprised of a plurality of rows and columns of photo sensing elements, with the rows aligned perpendicular to the first direction; wherein the motion of the carriage in the first direction is synchronized with the scanning of the imaging sensor so that as the image passes each row of sensor elements, the signal charge generated in the sensor is passed from one row to the next row, with the signals being summed over the plurality of rows before being transferred to a readout shift register; and providing an indication of the location of the edges of the perimeter and holes in the workpiece, relative to the location of the optical sensor and its photo sensing elements as it scans the on the table surface.

wherein the CCD camera is comprised of the CCD sensor and circuitry for timing and synchronization, analog to digital video conversion, and interfacing with the edge data processor board.

18. The inspection system recited in claim 17, wherein the computer workstation is comprised of a computer for data interfacing, processing and storage; plug-in circuit board slots; and software for data manipulation, measurement and comparison computations; and computer peripherals for data display and printing.

19. The inspection system recited in claim 17, wherein the edge data processor board plugs into the computer and is comprised of circuitry for interfacing with the clock, timing and digital

video signals from the CCD camera, bi-phase signal from the X-axis linear encoder; and for run length encoding of edge addresses and end of line into a first-in-first-out memory for buffering the data onto the computer data bus.